Ambiguity of Quality in Remote Sensing Data

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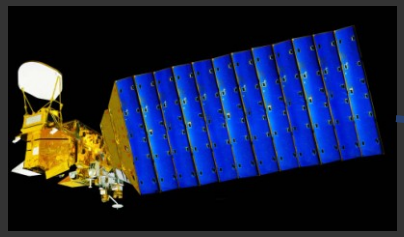
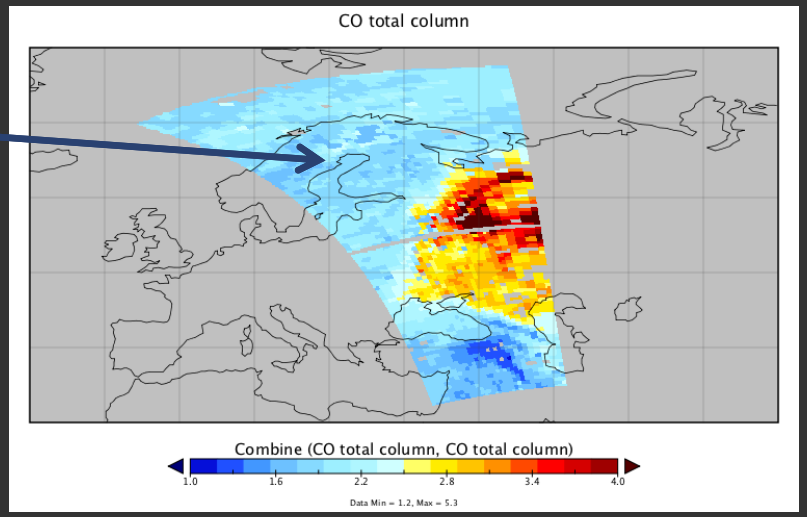
Data Quality Goal

- Describe data quality so that users understand:
  - What it means for the data
  - How to use quality information for data selection and analysis
- Why so difficult?
  - Data Quality depends on intended use
  - Data Quality = Fitness for Purpose

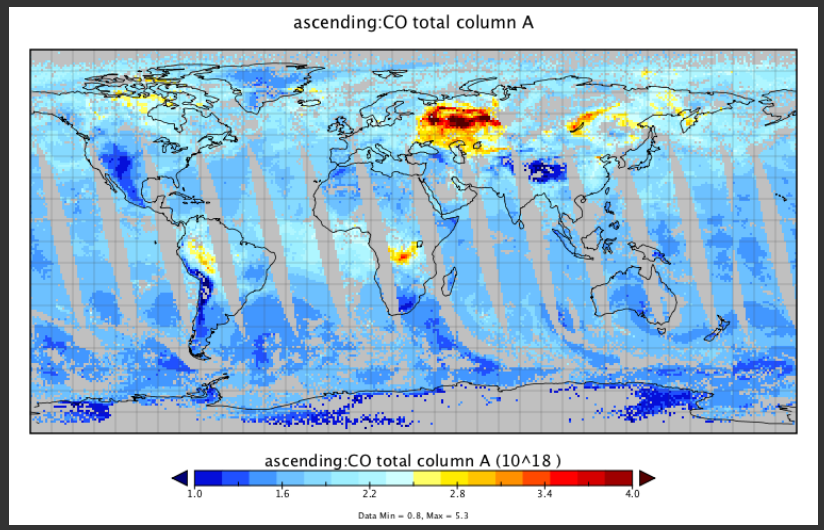
Satellite data swaths and grids





Level 2
Swath

Temporal
and Spatial
Aggregation



Level 3
Grid

A Survey of Data Quality at Different Levels of Aggregation

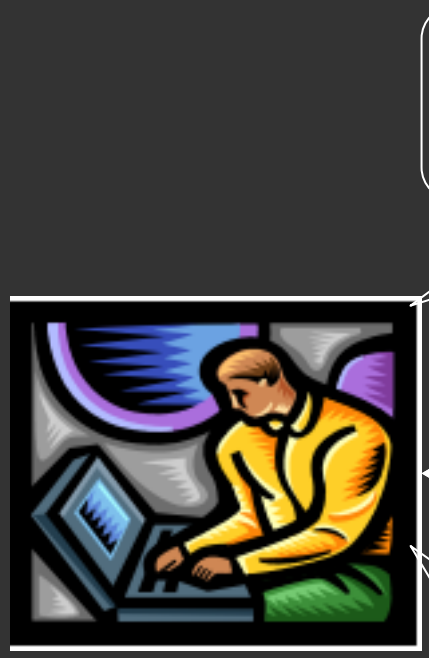
Increasing Aggregation →

↓ Increasing Aggregation

Type of Data	Data-Value Quality	Data-File Quality	Dataset* Quality
Level 2 Swath	Quality Control (QC) flags	Statistical summary of QC info	Statistical accuracy relative to validation sites
Level 3 Grid	•Cell std. dev. •Number of input values	Statistical summary of QC info	??

*Dataset = the assemblage of all the data values of the same typ

Contrasting dataset-level vs. data-value-level Use Cases



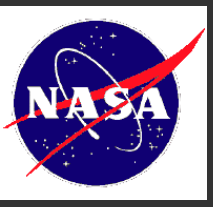
Give me just the good-quality data values

Quality Control

Data Provider

Tell me how good the dataset is

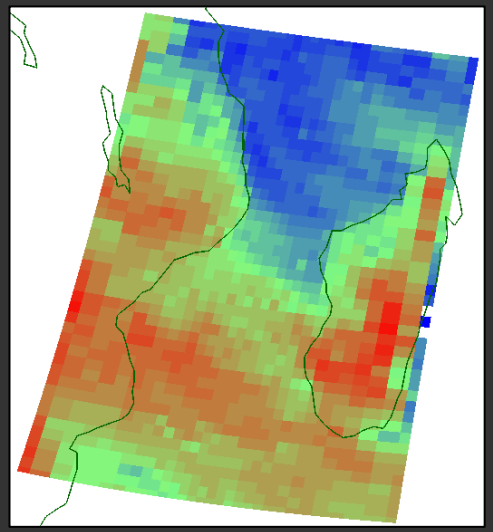
Quality Assessment



Data-Value Quality Control

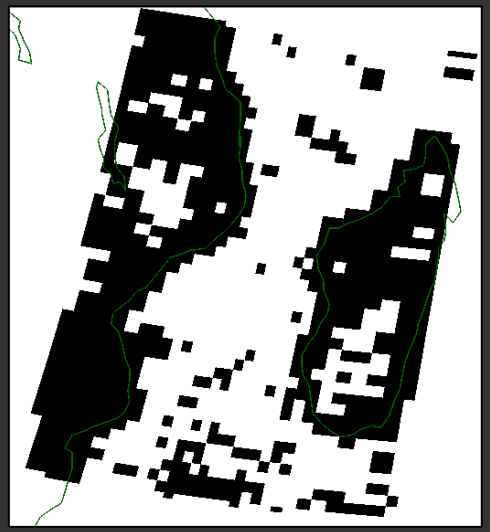
The Data Quality Screening Service: a straightforward example of data-value quality control

Original data array

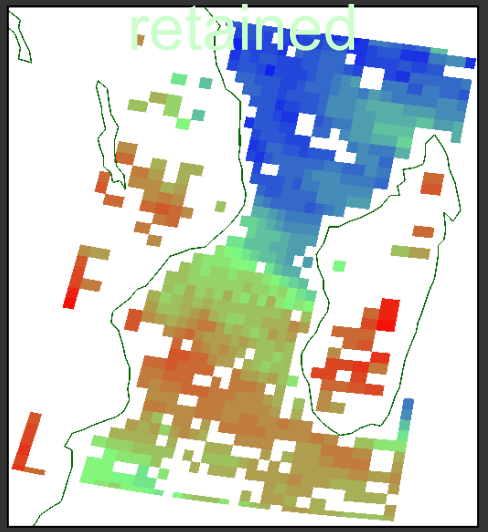


AIRS* Total column precipitable water

Mask based on quality flags



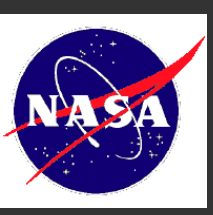
Good quality data pixels retained



Output file has the same format and structure as the input file, with fill values replacing the low-quality data

* Atmospheric Infrared Sounder

Or, maybe not so straightforward...



AIRS* Quality Indicators		MODIS Atmosphere** Confidence Flags
0 Best	?	3 Very Good
1 Good	?	2 Good
2 Do Not Use		1 Marginal
		0 Bad

* Atmospheric Infrared Sounder

** Moderate Resolution Imaging Spectroradiometer

Match up by recommendation?

AIRS Quality Indicators		MODIS Aerosols Confidence Flags			
		Ocean		Land	
0	Best	3	Very Good	3	Very Good
1	Good	2	Good	2	Good
2	Do Not Use	1	Marginal	1	Marginal
		0	Bad	0	Bad

Data Assimilatio

Climatic Studies

Use these flags in order to stay within expected error bounds

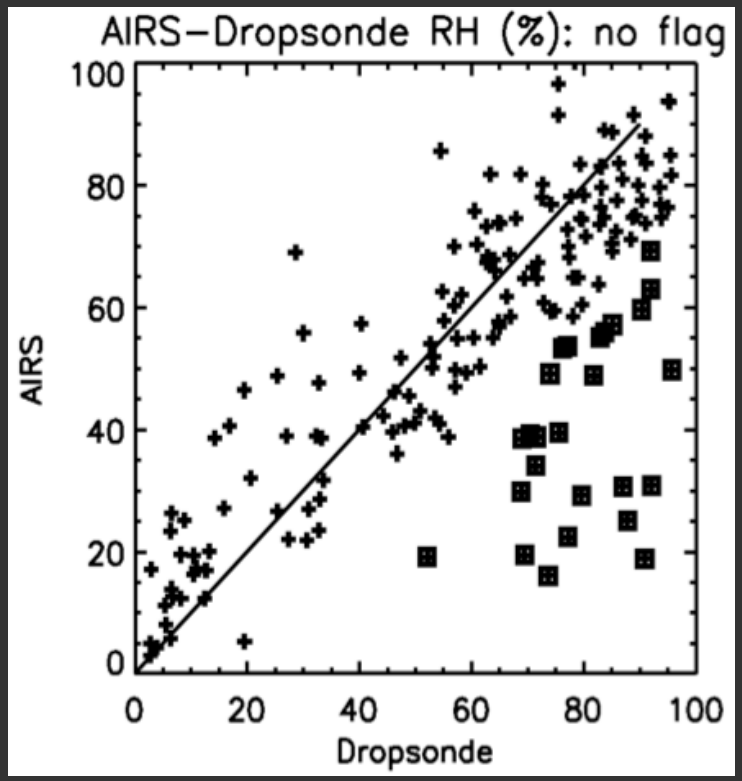
Ocean $\pm 0.03 \pm 0.10\ \tau$

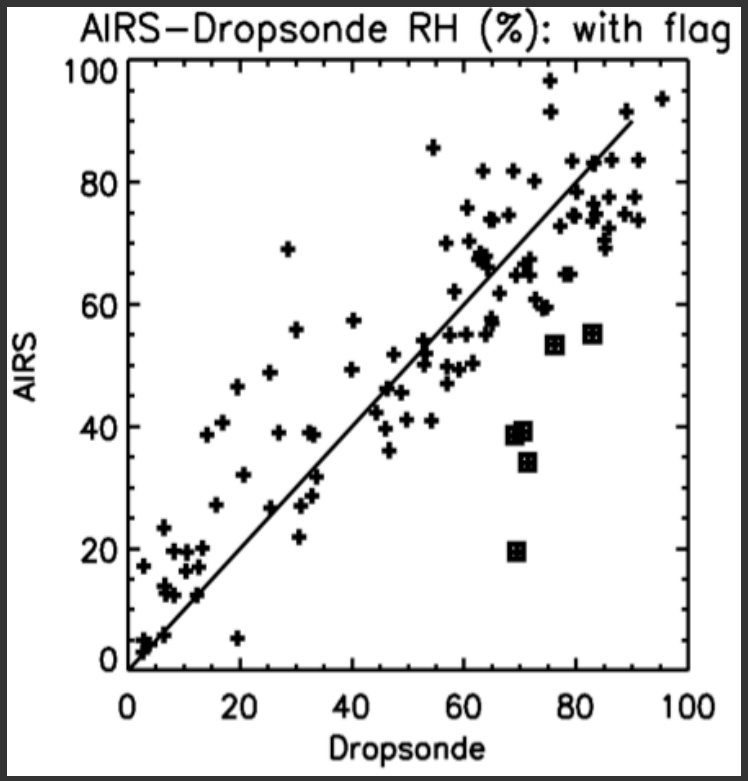
Land $\pm 0.05 \pm 0.15\ \tau$

How do quality control indicators relate to dataset quality assessment?

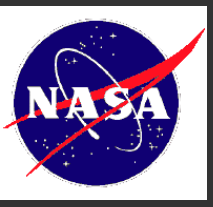
AIRS Relative Humidity Comparison against Dropsonde with and without Applying PBest Quality Flag Filtering

Boxed data points indicate AIRS RH data with dry bias > 20%





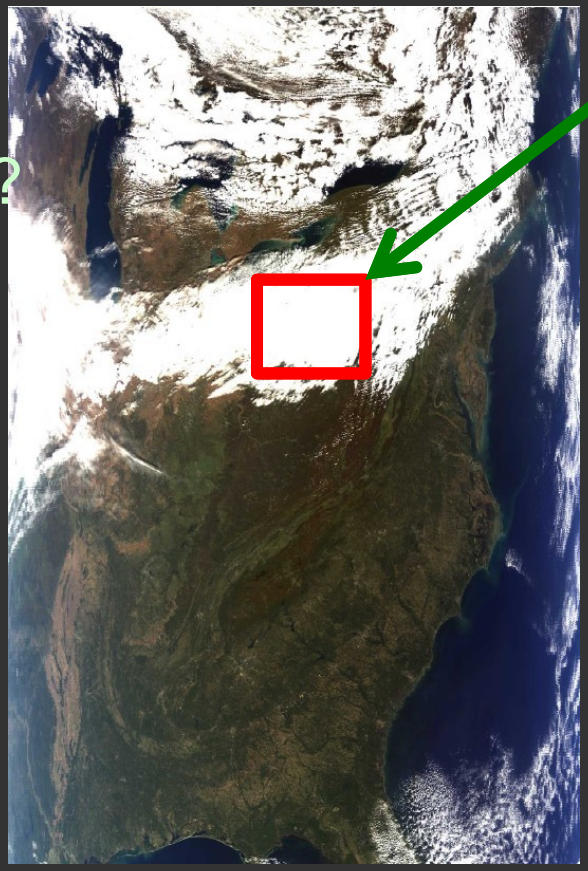
From a study by Sun Wong (JPL) on specific humidity in the Atlantic Main Development Region for Tropical Storms



Quality Measures of Aggregated Data

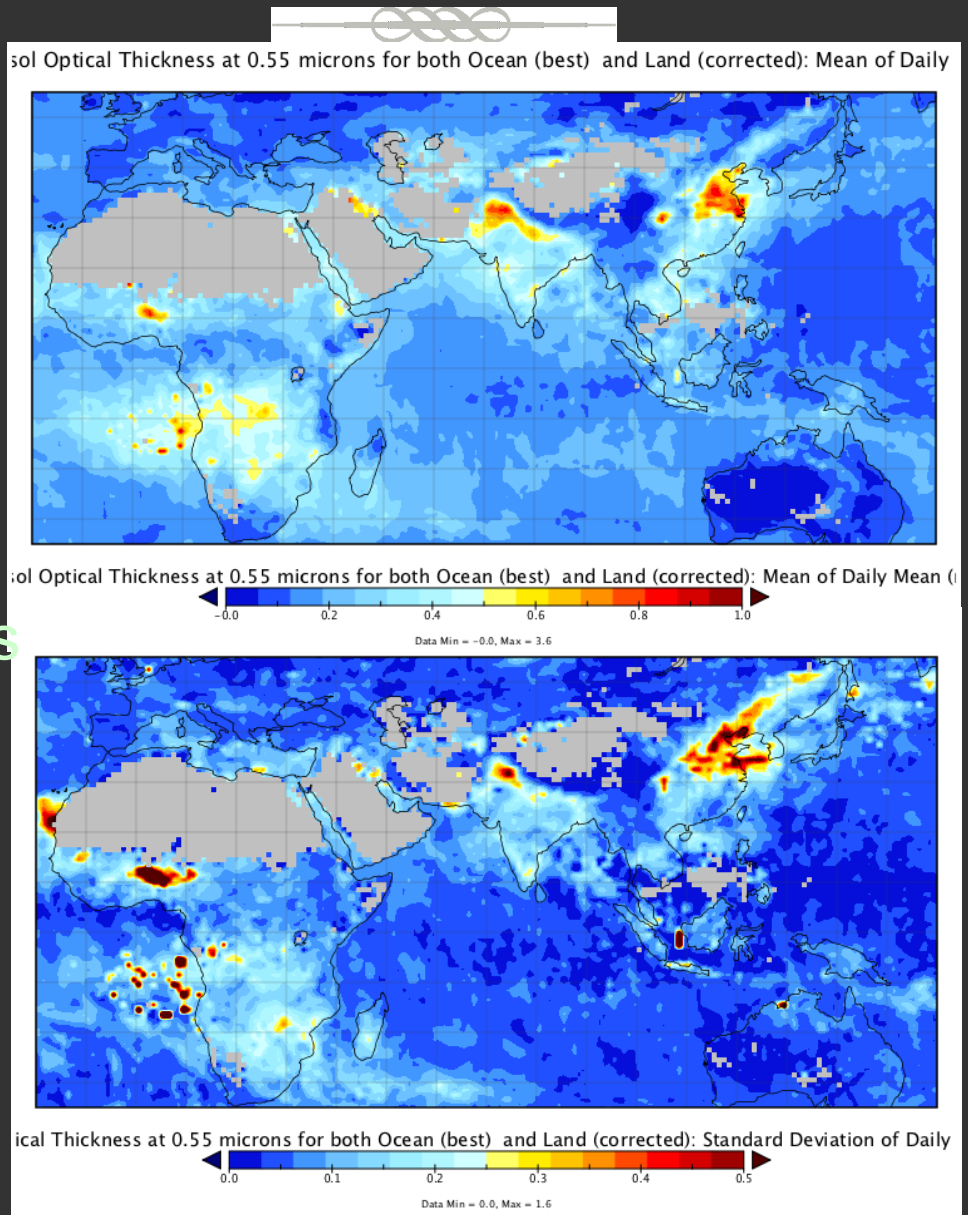
File-Level Quality Statistics may or may not be useful for data selection

Percent Cloud Cover?



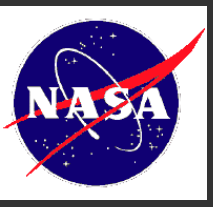
Level 3 grid cell standard deviation is difficult to interpret due to its dependence on magnitude

MODIS Aerosol Optical Thickness at 550 nm



Mean

Standard Deviation



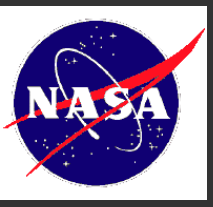
Potential Solution to Data Quality Ambiguity

Solution Part 1: Harmonize Quality Terms

- ISO 19115 Data Quality model
- Committee on Earth Observation Satellites (CEOS)
  - Quality Assurance for Earth Observations (QA4EO)
  - Working Group on Cal/Val (WGCV)
- Federation of Earth Science Information Partners
  - ESIP Information Quality Cluster
- Quality Ontology
  - Data Quality Screening Service: Data-value QC
  - Aerostat: Level 2 Bias
  - Multi-sensor Data Synergy Advisor: Bias, accuracy

Solution Part 2: Address more dimensions of Quality

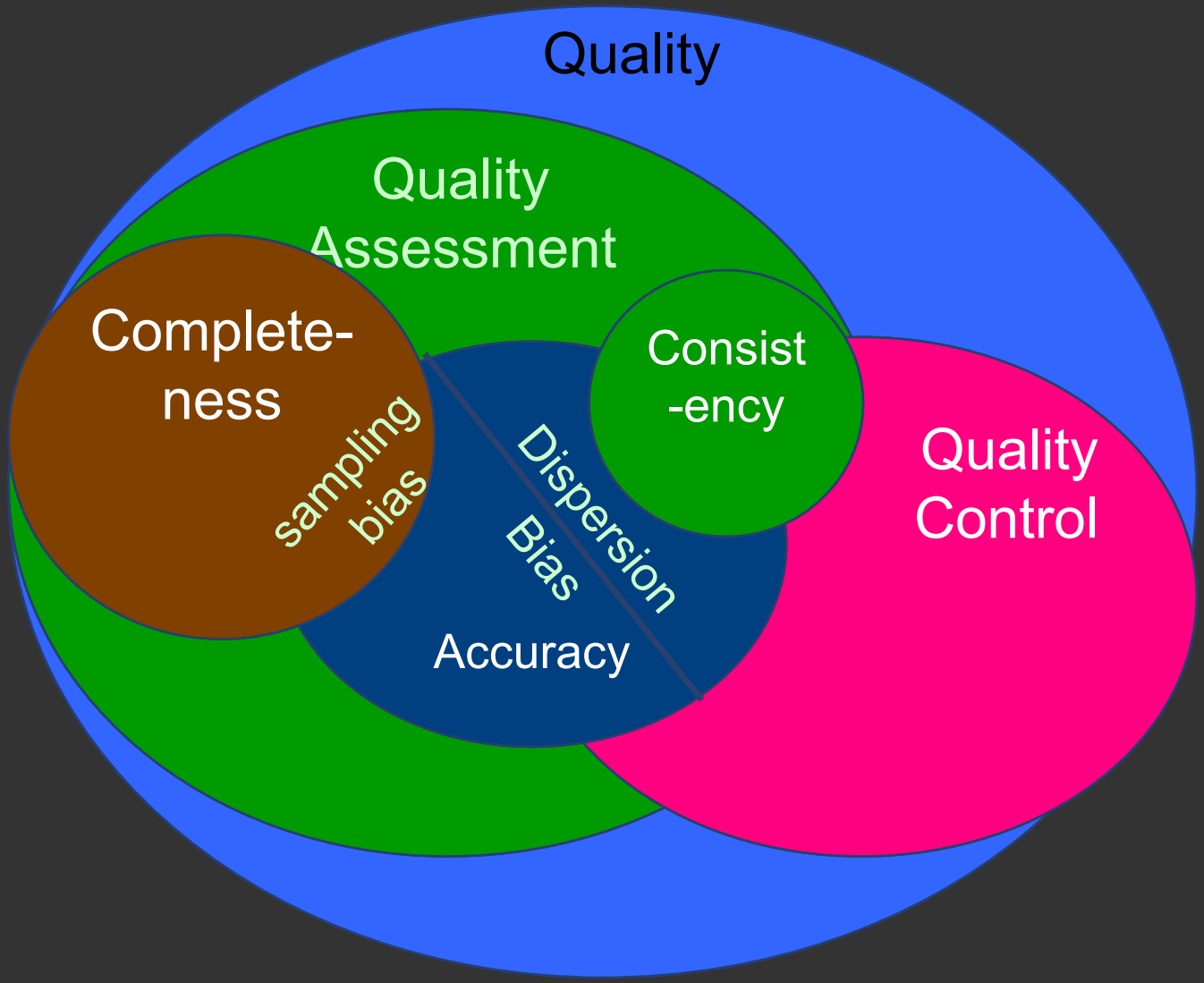
- Accuracy: bias + dispersion
  - Accuracy of data with low-quality flags
  - Accuracy of grid cell aggregations
- Consistency: spatial, temporal, observing conditions
- Completeness
  - Temporal: Time range, diurnal coverage, revisit frequency
  - Spatial: Coverage and Grid Cell Representativeness
  - Observing conditions
  - **N.B.: Incompleteness affects accuracy via sampling bias**

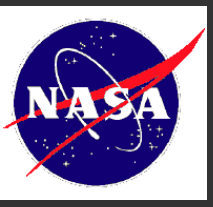


Solution Part 3: Address Fitness for Purpose Directly

- Standardize terms of recommendation
- Enumerate more positive realms and examples
- Enumerate negative examples

Facets of Quality



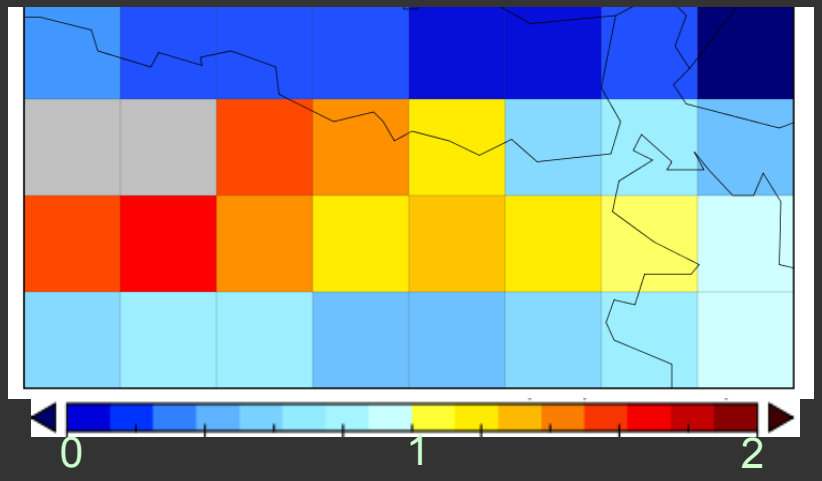


Backup Slides

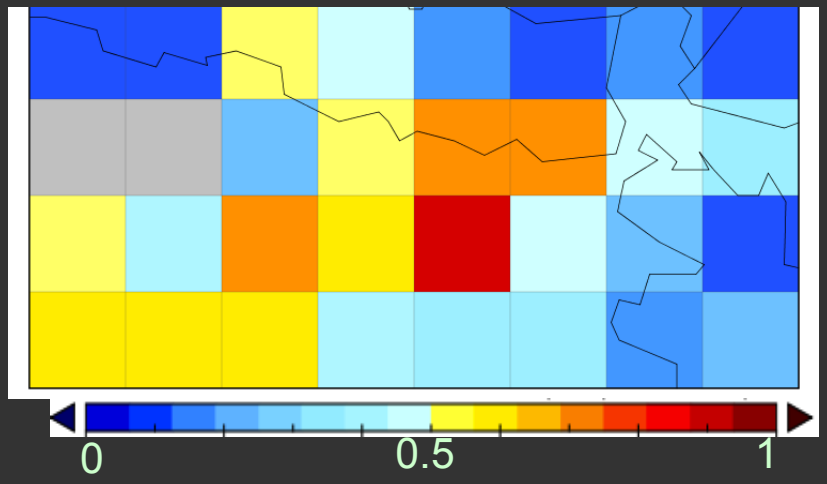
Neither pixel count nor standard deviation *fully* express how representative the grid cell value is

MODIS Aerosol Optical Thickness at 0.55 microns

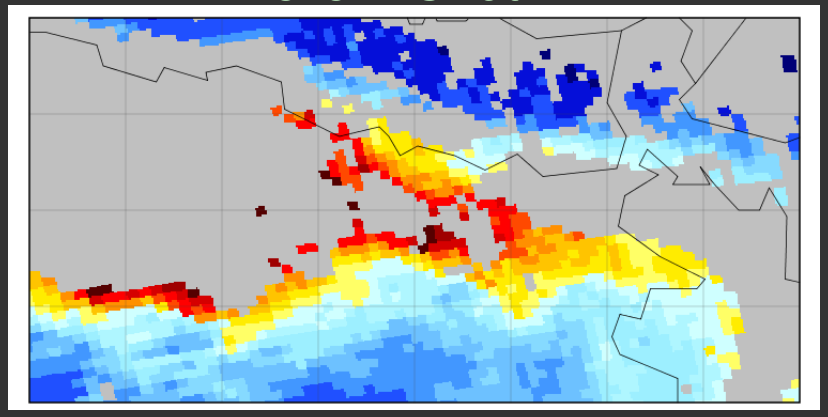
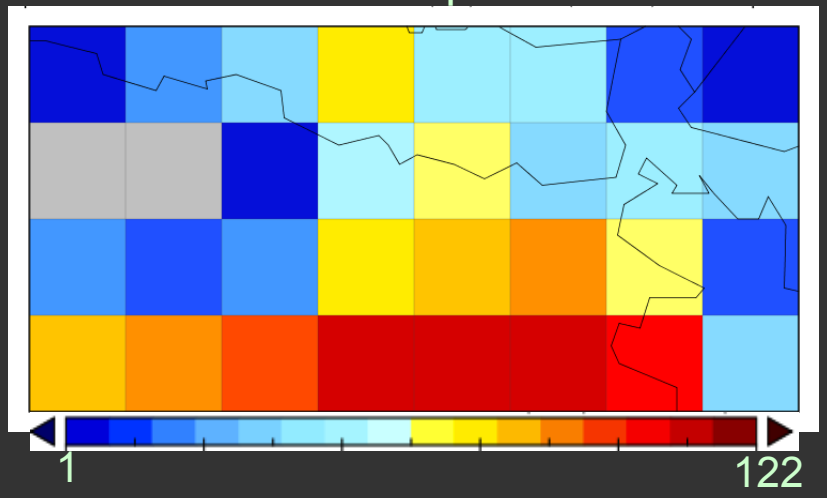
Level 3 Grid AOT Mean



Level 3 Grid AOT Standard Deviation



Level 2 Swath



Level 3 Grid AOT Input Pixel Count